Eco-Friendly Adsorption–Photodegradation of Basic Blue 41 by ZnO–Activated Carbon–Alginate Composites under Sunlight

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Abstract:

The sensitivity of synthetic dyes, such as Basic Blue 41 (BB41), poses significant impediments to industrial wastewater management, as they are highly persistent and toxic. The purpose of the study is to elaborate on an effective hybrid adsorption-photodegradation process to treat BB41. First, the adsorption of BB41 on commercial zinc oxide (ZnO) was optimized. Parameters such as the dose of adsorbent, the initial concentration of dye, and the pH were considered; the results obtained indicate a removal efficiency of 38.2 %. Under the best conditions (use of 0.61 g/L ZnO, pH 6) the adsorption capacity and equilibrium time were 0.53 mg/g and 180 min, respectively. Based on this, new photocatalytic composite materials were constructed by adding ZnO material to activated carbon (AC) and sodium alginate (SA). Such materials will be able to synergistically integrate the high specific surface area and adsorptive capacity of AC, the binding and swelling capacity of SA, and the photocatalytic effects of ZnO under sunlight. The experimental findings indicate that these composites are effective in removing BB41 with a removal up to 99.75 % compared to 47.47 % removal of commercial ZnO. This indicates a high possibility of these hybrid materials in sustainable and effective wastewater treatment.

Keywords:

Basic Blue 41 (BB41; Adsorption-photodegradation; Zinc oxide (ZnO); Activated carbon; Sunlight photodegradation; Wastewater treatment.